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Monthly Performance Report

SADDLE HILL TRUST

LOT 73

MARCH 1979

U.S. Department of Energy

National Solar Heating and Cooling Demonstration Program

National Solar Data Program

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MONTHLY PERFORMANCE REPORT

SADDLE HILL TRUST
LOT 73

MARCH 1979

I. SYSTEM DESCRIPTION

Saddle Hill Trust Lot 73 is a single-family residence in Medway, Massachusetts. Solar energy is used for preheating incoming city water. The system has an array of flat-plate collectors with a gross area of 45 square feet. The array faces south at an angle of 45 degrees to the horizontal. A 60 percent glycerol solution is used as the medium for delivering solar energy from the collector array to storage. Water is the transport medium that delivers solar energy to storage and to the domestic-hot-water (DHW) heater. Solar energy is stored in the basement in an 80-gallon preheat tank. This preheated city water is supplied, on demand, to a conventional 40-gallon DHW tank. When solar energy is insufficient to satisfy the hot water requirements, the gas-driven DHW heater provides auxiliary energy for water heating. The system, shown schematically in Figure 1, has two modes of solar operation.

Mode 1 - Collector-to-Storage: This mode activates when a 40°F temperature difference exists between the collector and the preheat tank. Pump P1 is on. This mode continues operating until the temperature difference drops to 20°F.

Mode 2 - Storage-to-DHW Tank: This mode activates when there is a demand for hot water. Hot water from the top of the preheat tank is transferred to the DHW tank to replace the amount removed. Simultaneously, city water is automatically supplied to the preheat tank.

II. PERFORMANCE EVALUATION

INTRODUCTION

The site was occupied in March and the solar energy system operated continuously during the month. Solar energy satisfied 45 percent of the DHW requirements. The solar energy system provided a fossil fuel energy savings of 1.1 million Btu and incurred an electrical energy expense of 0.14 million Btu.

WEATHER CONDITIONS

During the month, total incident solar energy on the collector array was 1.7 million Btu for a daily average of 1206 Btu per square foot. This was below the estimated average daily solar radiation for this geographical area during March of 1237 Btu per square foot for a south-facing plane with a tilt of 45 degrees to the horizontal. The average ambient temperature during March was 41°F as compared with the long-term average for March of 38°F.

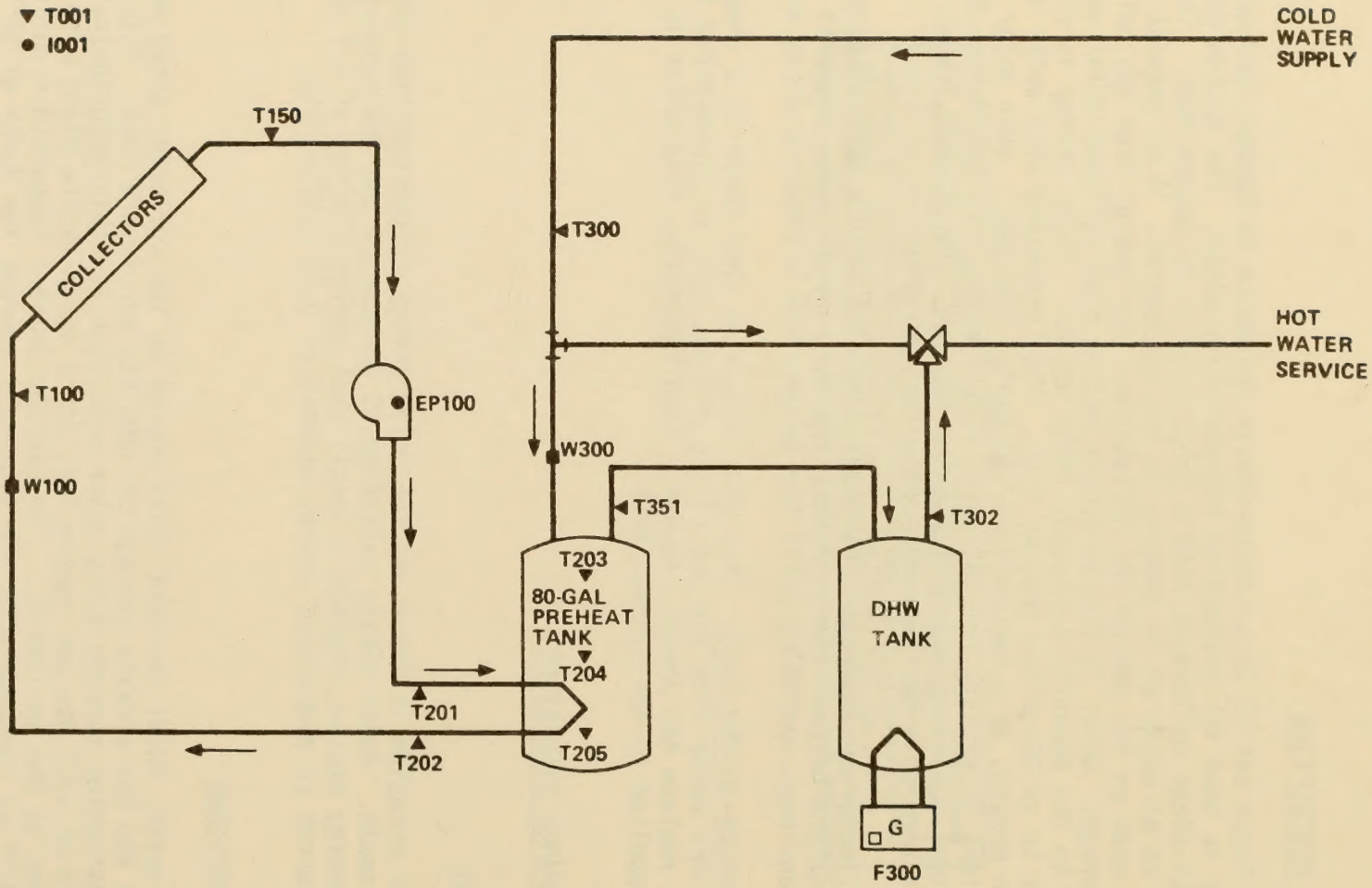

Figure 1. SADDLE HILL TRUST, LOT NO. 73 SOLAR ENERGY SYSTEM SCHEMATIC

THERMAL PERFORMANCE

System - During March the solar energy system performed approximately as expected. The expected performance was determined from a modified f-chart analysis using measured weather and subsystem loads as inputs. Solar energy collected was 0.99 million Btu versus an estimated 0.80 million Btu. Solar energy used by the system was estimated by assuming that all energy collected would be applied to the load. Actual solar energy used was 0.68 million Btu. System total solar fraction was 45 percent versus an estimated 50 percent.

Collector - The total incident solar radiation on the collector array for the month of March was 1.7 million Btu. During the period the collector loop was operating, the total insolation amounted to 1.5 million Btu. The total collected solar energy for the month of March was 0.99 million Btu, resulting in a collector array efficiency of 59 percent, based on total incident insolation. Solar energy delivered from the collector array to storage was 0.89 million Btu. Energy loss during transfer from the collector array to storage was 0.10 million Btu. This loss represented 10 percent of the energy collected. Operating energy required by the collector loop was 0.14 million Btu.

Storage - Solar energy delivered to storage was 0.89 million Btu. There were 0.68 million Btu delivered from storage to the DHW subsystem. Energy loss from storage was 0.24 million Btu. This loss represented 27 percent of the energy delivered to storage. The storage efficiency was 73 percent: This is calculated as the ratio of the sum of the energy removed from storage and the change in stored energy, to the energy delivered to storage. The average storage temperature for the month was 77°F.

DHW Load - The DHW subsystem consumed 0.68 million Btu of solar energy and 1.5 million Btu of auxiliary fossil fuel energy to satisfy a hot water load of 1.4 million Btu. The solar fraction of this load was 45 percent. Losses from the DHW subsystem were 0.24 million Btu. A daily average of 59 gallons of DHW was consumed at an average temperature of 131°F delivered from the tank.

OBSERVATIONS

A portion of the 0.24 million Btu loss in the DHW subsystem was probably used to maintain the DHW tank temperature.

ENERGY SAVINGS

The solar energy system provided a fossil fuel savings of 1.1 million Btu and incurred an electrical energy expense of 0.14 million Btu.

III. ACTION STATUS

No action is required at this time.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: SADDLE HILLS TRUST LOT #73 , MEDWAY, MA 02053 SOLAR/1039-79/03
REPORT PERIOD: MARCH,1979

SITE/SYSTEM DESCRIPTION:
THE SADDLE HILL TRUST, LOT #73 SOLAR ENERGY SYSTEM FURNISHES HOT WATER YEAR-ROUND TO A SINGLE FAMILY DWELLING. THE COLLECTOR IS A 2 PANEL DAYSTAR 20 LIQUID COLLECTOR. STORAGE SPACE IS AN 80 GALLON WATER TANK. AUXILIARY HOT WATER IS PROVIDED BY A 40,000 BTU/HR GAS HOT WATER HEATER.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	1.682	MILLION BTU
	37389	BTU/SQ.FT.
COLLECTED SOLAR ENERGY	0.986	MILLION BTU
	21916	BTU/SQ.FT.
AVERAGE AMBIENT TEMPERATURE	41	DEGREES F
AVERAGE BUILDING TEMPERATURE	N.A.	DEGREES F
ECSS SOLAR CONVERSION EFFICIENCY	0.41	
ECSS OPERATING ENERGY	0.141	MILLION BTU
TOTAL SYSTEM OPERATING ENERGY	0.141	MILLION BTU
TOTAL ENERGY CONSUMED	2.663	MILLION BTU

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	1.371	N.A.	N.A.	1.371 MILLION BTU
SOLAR FRACTION	45	N.A.	N.A.	45 PERCENT
SOLAR ENERGY USED	0.684	N.A.	N.A.	0.684 MILLION BTU
OPERATING ENERGY	N.A.	N.A.	N.A.	0.141 MILLION BTU
AUX. THERMAL ENERGY	0.922	N.A.	N.A.	0.922 MILLION BTU
AUX. ELECTRIC FUEL	N.A.	N.A.	N.A.	N.A. MILLION BTU
AUX. FOSSIL FUEL	1.536	N.A.	N.A.	1.536 MILLION BTU
ELECTRICAL SAVINGS	N.A.	N.A.	N.A.	-0.141 MILLION BTU
FOSSIL SAVINGS	1.140	N.A.	N.A.	1.140 MILLION BTU

SYSTEM PERFORMANCE FACTOR: 0.684

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978. SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: SADDLE HILLS TRUST LOT #73 , MEDWAY, MA 02053 SOLAR/1039-79/03
REPORT PERIOD: MARCH, 1979

SITE/SYSTEM DESCRIPTION:
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GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	1.775 GIGA JOULES
	424587 KJ/SQ.M.
COLLECTED SOLAR ENERGY	1.040 GIGA JOULES
	248880 KJ/SQ.M.
AVERAGE AMBIENT TEMPERATURE	5 DEGREES C
AVERAGE BUILDING TEMPERATURE	N.A. DEGREES C
ECSS SOLAR CONVERSION EFFICIENCY	0.41
ECSS OPERATING ENERGY	0.148 GIGA JOULES
TOTAL SYSTEM OPERATING ENERGY	0.148 GIGA JOULES
TOTAL ENERGY CONSUMED	2.809 GIGA JOULES

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	1.446	N.A.	N.A.	1.446 GIGA JOULES
SOLAR FRACTION	45	N.A.	N.A.	45 PERCENT
SOLAR ENERGY USED	0.722	N.A.	N.A.	0.722 GIGA JOULES
OPERATING ENERGY	N.A.	N.A.	N.A.	0.148 GIGA JOULES
AUX. THERMAL ENG	0.972	N.A.	N.A.	0.972 GIGA JOULES
AUX. ELECTRIC FUEL	N.A.	N.A.	N.A.	N.A. GIGA JOULES
AUX. FOSSIL FUEL	1.621	N.A.	N.A.	1.621 GIGA JOULES
ELECTRICAL SAVINGS	N.A.	N.A.	N.A.	-0.148 GIGA JOULES
FOSSIL SAVINGS	1.203	N.A.	N.A.	1.203 GIGA JOULES

SYSTEM PERFORMANCE FACTOR: 0.684

* DENOTES UNAVAILABLE DATA
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REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM, FEBRUARY 28, 1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: SADDLE HILLS TRUST LOT #73 , MEDWAY, MA 02053 SOLAR/1039-79/03
REPORT PERIOD: MARCH,1979

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	AMBIENT TEMP DEG-F	ENERGY TO LOADS MILLION BTU	AUX THERMAL TO ECSS MILLION BTU	ECSS OPERATING ENERGY MILLION BTU	ECSS ENERGY REJECTED MILLION BTU	ECSS SOLAR CONVERSION EFFICIENCY
1	0.053	36	0.026	N	0.004	N	0.481
2	0.010	36	0.028	O	0.002	O	2.817
3	0.033	36	0.016	T	0.004	T	0.468
4	0.025	39	0.013		0.004		0.530
5	0.040	54	0.008	A	0.005	A	0.197
6	0.008	50	0.014	P	0.000	P	1.868
7	0.006	44	0.008	P	0.000	P	1.471
8	0.019	42	0.008	L	0.006	L	0.407
9	0.077	41	0.005	I	0.005	I	0.065
10	0.009	38	0.023	C	0.000	C	2.563
11	0.013	36	0.011	A	0.003	A	0.813
12	0.070	28	0.011	B	0.006	B	0.152
13	0.069	33	0.023	L	0.006	L	0.329
14	0.018	48	0.027	E	0.005	E	1.503
15	0.103	27	0.007		0.006		0.066
16	0.089	26	0.032		0.006		0.361
17	0.105	31	0.049		0.006		0.471
18	0.070	28	0.044		0.006		0.624
19	0.048	39	0.015		0.005		0.306
20	0.093	45	0.026		0.006		0.277
21	0.065	44	0.036		0.005		0.551
22	0.107	50	0.020		0.006		0.190
23	0.101	53	0.043		0.007		0.420
24	0.063	50	0.032		0.006		0.510
25	0.010	51	0.021		0.003		2.210
26	0.099	46	0.014		0.006		0.141
27	0.110	36	0.045		0.006		0.407
28	0.111	40	0.048		0.006		0.431
29	0.021	42	0.019		0.004		0.900
30	0.012	45	0.007		0.003		0.602
31	0.027	46	0.008		0.004		0.309
SUM	1.682	-	0.684	N.A.	0.141	N.A.	-
AVG	0.054	41	0.022	N.A.	0.005	N.A.	0.407
NBS ID	Q001	N113			Q102		N111

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
COLLECTOR ARRAY PERFORMANCE

SITE: SADDLE HILLS TRUST LOT #73 , MEDWAY, MA 0205SOLAR/1039-79/03
REPORT PERIOD: MARCH,1979

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	OPERATIONAL INCIDENT ENERGY MILLION BTU	COLLECTED SOLAR ENERGY MILLION BTU	DAYTIME AMBIENT TEMP DEG F	COLLECTOR ARRAY EFFICIENCY
1	0.053	0.046	0.028	49	0.535
2	0.010	0.005	0.003	37	0.263
3	0.033	0.029	0.019	40	0.578
4	0.025	0.021	0.014	43	0.570
5	0.040	0.037	0.029	62	0.716
6	0.008	0.000	0.000	52	0.000
7	0.006	0.000	0.000	43	0.000
8	0.019	0.016	0.009	48	0.479
9	0.077	0.074	0.052	52	0.675
10	0.009	0.000	0.000	43	0.000
11	0.013	0.008	0.004	40	0.296
12	0.070	0.065	0.039	37	0.560
13	0.069	0.062	0.039	38	0.573
14	0.018	0.015	0.010	54	0.526
15	0.103	0.096	0.057	35	0.552
16	0.089	0.082	0.048	37	0.535
17	0.105	0.097	0.065	43	0.618
18	0.070	0.066	0.041	37	0.590
19	0.048	0.044	0.030	47	0.629
20	0.093	0.088	0.060	56	0.646
21	0.065	0.061	0.043	50	0.671
22	0.107	0.100	0.072	71	0.673
23	0.101	0.096	0.065	73	0.640
24	0.063	0.059	0.040	61	0.635
25	0.010	0.004	0.002	52	0.201
26	0.099	0.093	0.061	60	0.615
27	0.110	0.103	0.061	46	0.552
28	0.111	0.103	0.065	54	0.588
29	0.021	0.016	0.011	46	0.518
30	0.012	0.005	0.003	47	0.226
31	0.027	0.023	0.016	47	0.611
SUM	1.682	1.511	0.986	-	-
AVG	0.054	0.049	0.032	48	0.586
NBSID	Q001		Q100		N100

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
STORAGE PERFORMANCE

SITE: SADDLE HILLS TRUST LOT #73 , MEDWAY, MA 0205SOLAR/1039-79/03
REPORT PERIOD: MARCH,1979

DAY OF MONTH	ENERGY TO STORAGE MILLION BTU	ENERGY FROM STORAGE MILLION BTU	CHANGE IN STORED ENERGY MILLION BTU	STORAGE AVERAGE TEMP DEG F	STORAGE EFFICIENCY
1	0.023	0.026	-0.013	101	0.531
2	0.005	0.028	-0.026	63	0.356
3	0.017	0.016	0.002	56	1.019
4	0.012	0.013	0.000	55	1.085
5	0.025	0.008	0.015	55	0.915
6	0.000	0.014	-0.016	66	1.000
7	0.000	0.008	-0.005	48	1.000
8	0.012	0.008	0.005	50	1.092
9	0.049	0.005	0.032	75	0.745
10	0.000	0.023	-0.026	74	1.000
11	0.006	0.011	-0.004	58	1.085
12	0.035	0.011	0.018	69	0.818
13	0.033	0.023	-0.001	84	0.639
14	0.009	0.027	-0.019	68	0.892
15	0.052	0.007	0.034	79	0.795
16	0.042	0.032	-0.006	102	0.622
17	0.059	0.049	-0.013	92	0.619
18	0.037	0.044	-0.017	75	0.739
19	0.027	0.015	0.009	62	0.880
20	0.055	0.026	0.016	81	0.770
21	0.039	0.036	-0.011	87	0.630
22	0.064	0.020	0.028	97	0.748
23	0.059	0.043	-0.003	111	0.673
24	0.038	0.032	-0.007	98	0.661
25	0.003	0.021	-0.022	76	-0.191
26	0.055	0.014	0.029	90	0.769
27	0.053	0.045	-0.014	108	0.576
28	0.058	0.048	-0.001	96	0.803
29	0.009	0.019	-0.013	65	0.587
30	0.004	0.007	-0.003	61	1.038
31	0.014	0.008	0.005	63	0.962
SUM	0.894	0.684	-0.028	-	-
AVG	0.029	0.022	-0.001	77	0.733
NBS ID	Q200	Q201	Q202		N108

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
HOT WATER SUBSYSTEM

SITE: SADDLE HILLS TRUST LOT #73 , MEDWAY, MA 02053 SOLAR/1039-79/03
REPORT PERIOD: MARCH,1979

DAY OF MON.	HOT WATER LOAD MILLION BTU	SOLAR FR.OF LOAD PER CENT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	SUP. WAT. TEMP DEG F	HOT WAT. TEMP DEG F	HOT WATER USED GAL
1	0.035	54	0.026	N	0.019	N	0.032	N	0.043	50	127	46
2	0.063	52	0.028	O	0.043	O	0.071	O	0.047	44	133	80
3	0.063	27	0.016	T	0.056	T	0.094	T	0.026	44	139	75
4	0.060	23	0.013		0.055		0.092		0.022	46	140	70
5	0.031	20	0.008	A	0.030	A	0.050	A	0.013	50	135	39
6	0.040	24	0.014	P	0.042	P	0.069	P	0.024	49	131	51
7	0.050	21	0.008	P	0.049	P	0.081	P	0.014	47	139	62
8	0.048	14	0.008	L	0.047	L	0.078	L	0.013	43	138	59
9	0.025	16	0.005	I	0.026	I	0.043	I	0.008	39	138	32
10	0.034	34	0.023	C	0.021	C	0.035	C	0.038	43	130	48
11	0.034	33	0.011	A	0.031	A	0.052	A	0.018	44	133	43
12	0.054	22	0.011	B	0.054	B	0.090	B	0.018	43	138	65
13	0.041	31	0.023	L	0.030	L	0.049	L	0.038	49	134	56
14	0.062	42	0.027	E	0.043	E	0.072	E	0.045	42	131	81
15	0.026	32	0.007		0.027		0.046		0.011	50	130	33
16	0.043	47	0.032		0.014		0.024		0.054	46	126	61
17	0.068	64	0.049		0.030		0.051		0.082	45	125	95
18	0.070	59	0.044		0.035		0.058		0.073	44	127	98
19	0.044	41	0.015		0.038		0.064		0.024	45	135	57
20	0.061	35	0.026		0.043		0.072		0.043	46	134	79
21	0.051	53	0.036		0.020		0.033		0.059	48	128	71
22	0.027	59	0.020		0.009		0.015		0.034	47	127	39
23	0.041	84	0.043		0.000		0.000		0.071	56	119	65
24	0.035	92	0.032		0.008		0.014		0.054	56	123	53
25	0.035	64	0.021		0.017		0.029		0.035	48	132	47
26	0.027	49	0.014		0.018		0.030		0.023	50	132	37
27	0.046	73	0.045		0.007		0.011		0.075	50	126	71
28	0.049	88	0.048		0.006		0.011		0.080	48	123	73
29	0.040	66	0.019		0.031		0.051		0.031	52	131	58
30	0.033	35	0.007		0.032		0.053		0.012	51	131	46
31	0.036	22	0.008		0.040		0.066		0.014	48	134	47
SUM	1.371	-	0.684	N.A.	0.922	N.A.	1.536	N.A.	1.140	-	-	1839
AVG	0.044	45	0.022	N.A.	0.030	N.A.	0.050	N.A.	0.037	47	131	59
NBS	Q302	N300	Q300	Q303	Q301	Q305	Q306	Q311	Q313	N305	N307	N308

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENVIRONMENTAL SUMMARY

SITE: SADDLE HILLS TRUST LOT #73 . MEDWAY, MA 02053 SOLAR/1039-79/03
REPORT PERIOD: MARCH,1979

DAY OF MONTH	TOTAL INSOLATION BTU/SQ.FT	DIFFUSE INSOLATION BTU/SQ.FT	AMBIENT TEMPERATURE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTION DEGREES	WIND SPEED M.P.H.
1	1182	N	36	49	N	N	N
2	221	O	36	37	O	O	O
3	738	T	36	40	T	T	T
4	557		39	43			
5	885	A	54	62	A	A	A
6	170	P	50	52	P	P	P
7	126	P	44	43	P	P	P
8	418	L	42	48	L	L	L
9	1719	I	41	52	I	I	I
10	196	C	38	43	C	C	C
11	287	A	36	40	A	A	A
12	1560	B	28	37	B	B	B
13	1531	L	33	38	L	L	L
14	401	E	48	54	E	E	E
15	2292		27	35			
16	1979		26	37			
17	2328		31	43			
18	1557		28	37			
19	1064		39	47			
20	2067		45	56			
21	1436		44	50			
22	2376		50	71			
23	2251		53	73			
24	1408		50	61			
25	211		51	52			
26	2193		46	60			
27	2443		36	46			
28	2464		40	54			
29	463		42	46			
30	267		45	47			
31	598		46	47			
SUM	37389	N.A.	-	-	-	-	-
AVG	1206	N.A.	41	48	N.A.	N.A.	N.A.
NBS ID	Q001		N113			N115	N114

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

*U.S. GOVERNMENT PRINTING OFFICE: 1980-640-189/4092. Region 4.

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